NON-NATIVE RED SWAMP CRAYFISH (*PROCAMBARUS CLARKII*): REMOVAL EFFORTS AND ECOSYSTEM EFFECTS IN TOPANGA CREEK

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Introduction

The presence of non-native red swamp crayfish (*Procambarus clarkii)* in Topanga Creek was first recorded by the RCD in 2003. The population has since increased, with a clear spike in 2012. Within the Santa Monica Mountains, *P. clarkii* has been linked to diminishing numbers of California newt (*Taricha torosa*), a species of special concern. We posed the following questions:

- How far-reaching are the effects of this non-native in Topanga Creek?
- Does the presence of *P. clarkii* have adverse effects on water quality, endangered *Oncorhynchus mykiss*, or benthic macroinvertebrate assemblages?
- Can removal efforts be sustained effectively?

Red swamp crayfish *Procambarus clarkii*

Steelhead trout *Oncorhynchus mykiss*

CA tree frog *Pseudacris cadaverina*

Pacific tree frog *Pseudacris regilla*

CA newt *Taricha torosa*

Adult dragonfly Topanga Creek

Methods

STUDY DESIGN
- *P. clarkii* removed from a 200m reach of Topanga Creek
- *P. clarkii* were not removed in the upstream, adjacent 200 meters
- Three pools from each reach selected as study sites (total of 6 study sites)

Removal Efforts
- 5/13-2/14 Six schools participated in 11 removal events, 5-55 volunteers per event
- *P. clarkii* captured with hot dogs on string and a small hand net
- Length and sex recorded

WATER QUALITY MONITORING
- Water and air temperature, salinity, pH, conductivity, and dissolved oxygen measurements taken from 6 study sites

NUTRIENT SAMPLING
- Water samples collected 1/month from 6 study sites
- Analyzed for nitrate (NO3), nitrite (NO2), ammonia (NO2), phosphate (PO4), and turbidity levels

BENTHIC MACROINVERTEBRATES (BMI)
- 11/13, 12/13, and 2/14
- Kick nets were deployed 3x along 3 transects (9 kicks) in each reach
- BMI sorted, identified, and counted

AMPHIBIAN, CRAYFISH, FISH OBSERVATIONS
- RCD stream team snorkel survey Topanga Creek 0m-5000m
- Observations of crayfish, amphibians, and fish are recorded

O. MYKISS STOMACH SAMPLING
- Gastric lavage methods (Giles 1980)
- 43 in November 2010 & 13 in March 2011 (size range: 134-368 mm FL)
- Prey items were sorted, identified and counted

Results

1. What effects have removal efforts had on crayfish demographics?

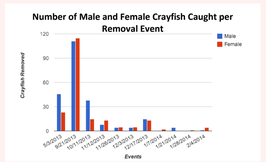

Figure 1: Total *p. clarkii* female =196, male =231

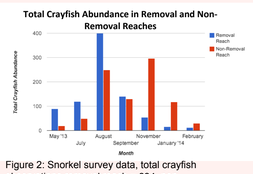

Figure 2: Snorkel survey data, total crayfish observations removal reach = 834, non-removal reach = 894

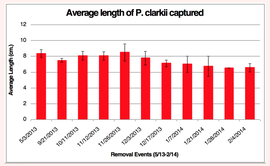

Figure 3: Crayfish measured from head to tail

Figure 4: Catch per unit effort (CPUE) = catch/(people x hours)

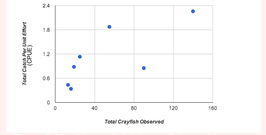

Figure 5: Monthly snorkel data crayfish count in removal reach vs. monthly average CPUE

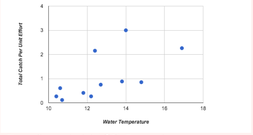

Figure 6: event's total CPUE vs. water average temperature during the event

- A total of 427 *p. clarkii* (231 male, 196 female) were removed over 11 events (Fig. 1)
- *P. clarkii* abundance appeared to peak in early fall in the removal reach, and late fall in the non removal reach in late fall 2013
- Mean length of P. clarkii removed declined from 8.3cm to 6.7cm May 2013 to Feb 2014 (Fig. 2)
- No significant difference in length between males and females
- Catch per unit effort (total catch/people x time) seems to be correlated with both total crayfish abundance and water temperature.

2. What effect has *p. clarkii* removal had on Topanga Creek water chemistry?

- No significant trends were found when comparing water temperature, dissolved oxygen, potential hydrogen, turbidity, or levels of nitrite, nitrate, ammonia, and phosphate between reaches (Fig. 7-8, 11-14)
- Salinity appears to be consistently higher in the non-removal reach; however, conductivity is constantly lower than in the removal reach (Fig. 9-10)

*LR: lower reach (removal reach) UR: upper reach (non-removal reach)
** Graphs are based on monthly averages of each reach

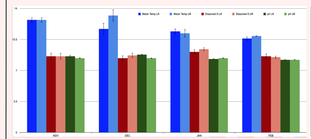

Figure 7

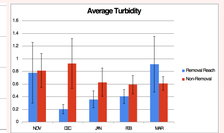

Figure 8

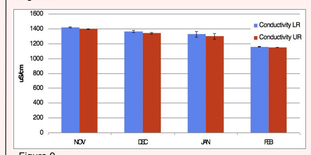

Figure 9

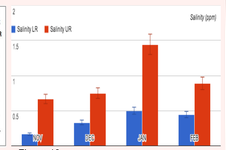

Figure 10

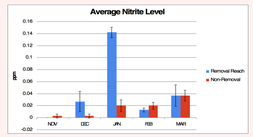

Figure 11

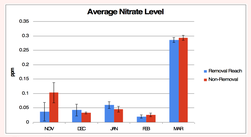

Figure 12

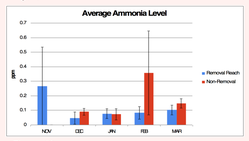

Figure 13

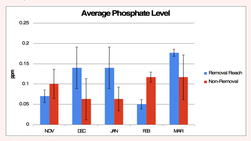

Figure 14

Chironomidae, amphipoda, and hydrobiidae have been the three most common BMI in the removal reach.

P. clarkii, amphipoda, and ostracod are the three most common BMI species in the non-removal reach.

- CA newt observations decreased from 100% frequency to <25% from 2001-2013
- *P. clarkii* observations increased from 0% frequency to 100% from 2001-2013 (fig. 15)
- O. mykiss young of the year were observed at more sites without p. clarkii presence (fig. 16)

3. What effects have *p. clarkii* had on Topanga Creek macroinvertebrate, amphibian and steelhead trout communities?

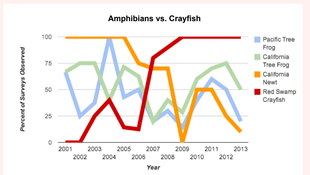

Figure 15: Data from 65 snorkel survey observations 2001-2013

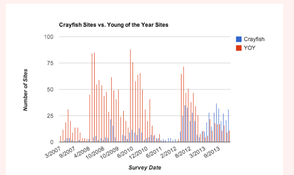

Figure 17: Data from 65 snorkel survey observations 2001-2013

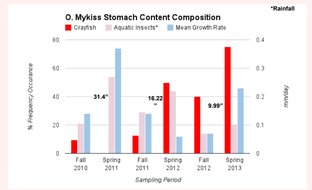

Figure 18: % Frequency Occurrence =# lavage samples containing prey item / total # samples
* Aquatic insect mean %FO includes diptera larva, baetidae nymphs, odonata nymphs, plecoptera, trichoptera, coleoptera, hemiptera
**Mean growth rates based on recaptures from previous sampling season

Table 1: Benthic Macroinvertebrate Indices of Biological integrity (BMI-IBI) 'EPT' = Ephemeroptera, Plecoptera, Trichoptera 'CG' =Collector-Gatherer 'FC'= Filterer-Collector 'SC' =Scraper 'P'=Predator

	Removal Reach (3500-3700m)	Non-Removal Reach (3700m-3900m)	Removal Reach (3500-3700m)	Non-Removal Reach (3700m-3900m)	Removal Reach (3500-3700m)	Non-Removal Reach (3700m-3900m)	Observed Response
Date	**11/20/2013**	**11/20/2013**	**12/5/2013**	**12/6/2013**	**2/20/2014**	**2/20/2014**	
Total Number Organisms	211	30	1263	148	2022	250	Decrease
Taxa Richness	**25**	**7**	**33**	**12**	**31**	**19**	**Decrease**
EPT Taxa	**3**	**2**	**7**	**0**	**5**	**3**	**Decrease**
% Dominant Taxon	42% (Chironomid-6)	30% (P. clarkii-8)	36% (Amphipoda-8)	39% (Amphipoda-8)	29% (Hydrobiidae-8)	45% (Ostracod-8)	N
Abundance (Bugs/1 sq. ft)	**23.4**	**3.3**	**140.3**	**7.7**	**110.7**	**27.6**	**Decrease**
Av. Tolerance Value	6.4	7.1	7.7	7.5	7.5	7.8	N
% Intolerant (0-2)	1.9%	0%	<1%	1.5%	1.4%	0	N
% Tolerant (8-10)	30%	40%	91%	82%	74%	92%	N
% CG	**72%**	**93%**	**46%**	**94%**	**51%**	**62%**	**Increase**
% FC	1%	0	0	0	0	1%	N
% SC	**18%**	**0**	**42%**	**4.5%**	**42%**	**25%**	**Decrease**
% P	10%	7%	11%	1.5%	7%	11%	N
Non-insect Taxa	**32%**	**43%**	**27%**	**55%**	**29%**	**47%**	**Increase**
Coleoptera Taxa	**6**	**1**	**5**	**3**	**7**	**2**	**Decrease**

- Frequency occurance of *P. clarkii* in *O. mykiss* stomach samples increased from 9.3 % to 75% from fall 2010 - spring 2013 (Fig. 17)
- BMI taxa richness, EPT Taxa, coleoptera taxa, and abundance was lower in the non-removal reach, while % collector-gatherers and non-insect taxa were higher (Table 1)

Discussion

Preliminary results indicate:
- *P. Clarkii* in Topanga Creek may more significantly impact community composition and O. mykiss diet than water chemistry.
- The most notable differences between the removal and non-removal reaches was the observed decline in macroinvertebrate and newt assemblages in the presence of crayfish.
- Reduced observed abundance of BMI and diminished BMI species richness in the non-removal reach are all indicative of a disturbed habitat.
- The two reaches were selected due to adjacent locations, similar habitat characteristics, and easy access; however, the upper (non-removal) reach is closer to the city of Topanga and has a culvert that releases highway runoff during rain events. These differences could contribute to declined BMI-IBI.
- Reduced observed abundance of newt over time seems to correlate strongly with *P. clarkii* introduction and spread. Whether newt declines are due to *P. clarkii* predation or distribution shifts for both species are symptoms of the same phenomena like drought, degraded habitat, or increased average temperatures is unknown at this time.
- We see value in future research to examine the effects of crayfish removal on steelhead trout growth, reproduction and BMI, amphibian species composition in additional reaches. Continued collection of data on crayfish diet, post-removal recolonization, average rainfall and temperature, will benefit future conservation efforts.

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